Effects of eutrophication and habitat heterogeneity on bacteria in lakes

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Bacterial communities central to aquatic ecosystem functioning
Widespread urban problem – Increasing with urban growth patterns – Climate warming

Photo: WFFF Colchester, VT
What’s happening in lakes of the Puget Sound watershed?
Major changes in several ecosystem functions as a result of eutrophication – such as the N cycle

\[ \delta^{15}N_{POM} \text{ (% vs. air)} \]

\[ \text{Hypolimnetic TP (µg L}^{-1} \text{)} \]

\[ \text{Percent of total N load} \]

\[ Jankowski \text{ et al. 2012} \]
How do bacteria respond to eutrophication?

- Not just the cyanobacteria (Zehr et al. 2007)
- Not just in the surface layer (Halm et al. 2009)
Eutrophication increases spatial variation in bacterial resources.
How do bacterial communities respond to lake eutrophication?

- 21 lakes across a gradient of nutrient loading
- Surveyed bacterial community abundance, richness and composition
- Evaluated communities throughout the water column: epi-, meta- and hypolimnion
Effects of eutrophication and habitat heterogeneity

Eutrophication Index

PC 1 (59 %)

PC 1 (19 %)

Hypo DO

Epi DO

Hypo TP

Epi TN

Chl a

Effects of eutrophication and habitat heterogeneity
Question 1. How do bacterial communities respond to eutrophication?
Question 1. How do bacterial communities respond to eutrophication?
Question 2. Does heterogeneity in the water column affect how associated bacterial communities respond to eutrophication?

<table>
<thead>
<tr>
<th>ABUNDANCE</th>
<th>Variable</th>
<th>n</th>
<th>k</th>
<th>R²</th>
<th>AIC</th>
<th>AICc</th>
<th>ΔAICc</th>
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<tbody>
<tr>
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<td>Eutrophication</td>
<td>21</td>
<td>3</td>
<td>0.46</td>
<td>610.8</td>
<td>612.2</td>
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<td></td>
<td>Heterogeneity</td>
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<td>3</td>
<td>0.66</td>
<td>601.7</td>
<td>603.1</td>
<td>0</td>
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<tr>
<td></td>
<td>Both</td>
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<td>3</td>
<td>0.61</td>
<td>604.4</td>
<td>605.8</td>
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<table>
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<th>Pooled richness</th>
<th>Variable</th>
<th>n</th>
<th>k</th>
<th>R²</th>
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<td>125.5</td>
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</table>
Communities become increasingly distinct among habitats in water column of eutrophic lakes.
Question 3. Which taxa are responding to increase in eutrophication?
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Conclusions

• Bacteria respond differently to lake eutrophication than other taxa

• Heterogeneity allows for diverse assemblage of bacteria to coexist, while retaining a core community

• Diversity promotes resilience of ecosystem function

• Restoration potential of ecosystem processes is higher because of retention of core functional groups?
Management tools?

• Use of functional genes as leading indicators of eutrophication (MacGregor et al. 2001)
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